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AUTHOR Gratz, Zandra S.; And Others
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ABSTRACT

A study was conducted at a large, state-supported college in the Northeast to establish a mechanism by which a popular software package, Statistical Package for the Social Sciences (SPSS), could be used in psychology program statistics courses in such a way that no prior computer expertise would be needed on the part of the faculty or the studehts. Central to the course was the development of a manual which provided detailed, step-by-step instructions for creating a database, uploading the file into SPSS, and then using SPSS to compute statistics typical of an introductory statistics course. Student achievement and attitudes were compared between a sample of 28 students whose statistics course relied on calculators (TRAD) and 27 students who used the manual to compute the necessary indices via SPSS (COMP). Study findings included the following: (1) there was no significant difference between the TRAD and COMP classes on multiple-choice scores, but TRAD students outperformed COMP students on open-ended questions, while COMP students were more likely to compute the desired statistic correctly than TRAD students; (2) there were no significant differences between TRAD and COMP students on measures of attitudes toward statistics, the discipline of psychology, or the course; (3) positive attitudes towards statistics increased over the course of the semester regardless of type of class; and (4) COMP class students were able to use the SPSS software and express pride in their computer skills and appreciation for the computer resources available. (AC)

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Attitudes and Achievement in Introductory Psychological Statistics Classes: Traditional versus Computer Supported Instruction

Zandra S. Gratz
Gloria D. Volpe
Bonnie M. Kind

Kean College of New Jersey

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Attitudes and Achievement in Introductory Psychological Statistics Classes: Traditional versus Computer Supported Instruction

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The impact of computer supported data analysis in an introductory statistics course was examined. In particular, the attitudes and achievement of students who used a computer to analyze data were compared to those who performed analyses via traditional calculator supported techniques. In addition, the extent to which a locally developed manual facilitated students' independent use of SPSS/PC was explored.

The role of computers in college level psychology instruction has been assessed via several surveys (Castellan, 1982; Butler & Kring, 1984; Stoloff & Couch, 1987). Across surveys, approximately 50 percent of the faculty respondents indicated they use computers in their instructional program. Although a trend in computer usage across time is not evident in these data, survey results indicate that among undergraduate course offerings, statistics is the most often cited course in which computers are used.

Research exists to dispel the myth that hand calculations benefit students' achievement in statistics courses. Layne & Huck (1981) failed to find support for the benefits of computations in helping students learn to interpret data. In other research, results indicate that students tend to report that extensive hand calculations interfered with their retention of what was learned as well as the learning of new material (Tromater, 1985). Research directly comparing the achievement of students who used computers to those who used calculators failed to find a significant difference (Ware & Chastain, 1989). In contrast to these results, however, a series of studies using computers in math instruction in which computers were found to facilitate increased student

achievement when compared to calculator supported instruction (Kulik, Bangert & Williams, 1983; Kulik & Kulik, 1989; Friedman, Jurkat & Pinkham, 1991). Differences in results between computer usage studies in statistics and math courses may be attributable to several factors. First there may be inherent differences in the disciplines which mitigate the extent to which computers may be of support. Second, more in line with Rogers' (1987) experience, it may be more difficult to identify a common set of items for computer and calculator supported statistics courses as compared to that of mathematics.

Despite limited empirical evidence to suggest that computers will increase achievement, Butler and Kring (1984) found that 75 percent of the psychology faculty surveyed believed student learning would be facilitated if computers were used to a greater extent in statistics classes. This may be the result of faculty perceptions that computers have become a necessity in psychological research. These perceptions may to some extent explain Butler and Kring's (1984) other finding that more faculty embraced the notion of computer supported statistics instruction than actually use computers as part of their statistics courses. Facility in computer methodology may partially explain the difference between faculty interest and faculty use.

Psychology faculty indicated the most likely mediator of future increases in computer usage would be the development of software; the area faculty believed most suitable for instructional computing development was statistics (Castellan, 1982). This result was surprising given the availability of powerful statistical packages such as SPSS but may be related to Castellan's (1982) finding that department chairs identified lack of faculty training to be the most often cited constraint on computer use. To address this limitation, statistical packages such as Elzey (1985) have been developed. Elzey requires little expertise to master and falls into the category defined by Butler and Eamon (1985) as useful for students in lab courses or faculty interested in analyzing small

size samples. Rogers (1987) used Elzey in his introductory statistics course and concluded "despite the difficulties caused by the programs' bugs and the textbook failings, using the package helped to create a good teaching situation" (p.111). Mainstays of social science research such as SPSS remain the preferred statistical package for data analysis. Recent survey results indicate SPSS to be the most frequently used statistical software package (Stoloff & Couch, 1987).

The current study sought to establish a mechanism by which the more popular software (SPSS) could be used in statistics courses in such a way that no prior computer expertise would be needed on the part of the faculty or students. In particular, the extent to which SPSS/PC could be made accessible to students having had no prior computer or statistics background was examined. Central to the course was the development of a manual which provided detailed, step by step instructions for creating a database using dBase, uploading the file into SPSS and then using SPSS/PC to compute statistics typical of an introductory statistics course. To examine the efficacy of this mode of instruction, achievement and attitudes were compared between a sample of students whose statistics course relied on calculators to those who used the manual to compute the necessary indices via SPSS/PC.

Method

Subjects and Setting

The current study was conducted at a large northeast state supported college which typically enrolls more than 10,000 students. Most students are among the first members of their families to attend college; approximately two thirds of the students study on a full time basis. The student body is racially and ethnically diverse with approximately 25 percent of the students African American and Hispanic. There are 330 resident faculty who reflect the diversity of the student body. The college offers a wide range of undergraduate majors.

The psychology department is located within the school of liberal arts. In addition to providing service courses for other departments, during the Fall 1992 semester, the psychology department enrolled 660 undergraduate majors; of these, approximately 42 percent jointly pursued majors in education. The department also offers several Master's Degree program enrolling 141 students during the Fall of 1992.

Subjects were 27 students enrolled in the computer supported statistics class (COMP) and 28 students enrolled in a traditional, calculator supported class (TRAD). Given the nature of the study, it was not possible to randomly assign subjects to conditions. Although the use of intact groups limits the internal validity of the study, as can be seen in Table 1, no significant differences were found between COMP and TRAD groups on several pre participation academic measures. In addition, as can be seen in Table 2, the relationship between class (TRAD and COMP) and academic major was not significant (Chi Square(2)=.12, p=.939).

Table 1
Academic Background of Subjects

Prior to Participation Measure	Mean TRAD	Mean COMP	t	p
Credits Completed	70.4	69.3	.28	.787
Number of Psychology Courses Taken	3.1	3.3	.35	.731
GPA in Psychology Courses Taken	8.9	8.6	.47	.638

Table 2
Academic Major of Participants

Academic Major	TRAD Number (%)	COMP Number (%)
Psychology Only	9 (32)	9 (33)
Psychology and Education	15 (54)	15 (56)
Other	4 (14)	3 (11)
Total	28	27

Materials

Central to this study was the development of a manual to facilitate students' independent access and use of dBase and SPSS/PC in an open laboratory environment. To measure participants' statistics achievement, a common item set was developed. In addition, several attitude measures were employed.

SPSS/PC Manual. Although SPSS/PC is menu driven, it is difficult to use. It is the authors' view that navigation through the SPSS/PC menu maze is inhibited by menu choices posted by acronyms or embedded within levels of choices difficult to delineate. To address these concerns, the manual was divided into chapters corresponding to each introductory statistics topic (e.g. Central Tendency) as well as several chapters guiding students through creating a data file for analysis. In addition, the manual presents explicit directions as to how to create a sample data set.

Within each chapter, the manual presented the menu options the student would see at each step, configured in a manner parallel to that seen on the screen. Also highlighted on each menu was the menu choice to be selected next. Directions specified the exact keys the student was to press to select the appropriate menu

choice. After each action, the manual presented what would appear on the screen subsequent to selecting each menu choice. After the final command to compute the desired statistic, the manual presented the output the student would see when the sample data set was used. The manual also labeled and defined each statistic printed.

Statistics Achievement. Over the course of the semester, students' statistics skills were measured by three tests. Each test contained both multiple choice and open ended questions. Typical of the open ended questions on the third test were problems requiring the student to determine the appropriate statistic, state the hypotheses, compute the value of the statistic and draw conclusions, For the purpose of this study, each test and item type contained a common core of items developed by the instructors of the TRAD and COMP sections. Across three tests, the common core yielded three scores including total multiple choice, total open ended and total number of statistical values computed correctly (a subsection of the open ended items).

Attitudes. Two attitude measures were used. The first was an adoption of the Semantic Differential's (SD) evaluative factor (Osgood, Suci & Tannenbaum, 1957). That is, similar to Ware and Chastain (1989), four bipolar items (good-bad, cruel-kind, clean-dirty, and beautiful-ugly) were posted with stimulus words Statistics and Computers. Expanding on Ware and Chastain (1989), the dimension of "valuable-worthless" was added; in addition, students were not only asked to rate Statistics and Computers but Mathematics and Psychology. Each item was scored from one to seven where seven indicated the more positive attitude. The four bipolar items used by Ware and Chastain (1989) were summed to generate a general attitude score (GEN). Information on the valuable-worthless item was dealt with separately as an indicator of subjects' perception as to the usefulness of statistics (USEFUL).

The second measure was the Attitude Toward Statistics scale (ATS) (Wise, 1985). The ATS contains 29 Likert type items which yield total and two subscale scores (field and course). The Coefficient Alpha reliability estimate of the ATS was .91; the concurrent validity coefficient linking the ATS with the Statistics Attitude Scale was .88 (Roberts and Reese, 1987).

Computer Laboratory. COMP classes were held in a computer laboratory which contained 16 IBM personal computers. Residing on the hard drive of each computer was SPSS/PC and dBase III+, among other programs. Each computer had one 3.5 floppy disk drive.

Procedure

Colleagues of the instructors administered the SD survey during the first and last day of the semester to both TRAD and COMP course students. Both classes received standard statistics instruction in lecture and discussion format. When specific statistics were to be calculated, TRAD students relied on hand calculators while COMP students relied on the computer. When computing a statistic, COMP students were instructed to proceed at their own pace and independently use the computer and manual. The instructor's primary role at this time was to answer students' questions. Students took each of the three achievement tests during a regularly scheduled class. During testing, TRAD students had calculators available while COMP students had computers available. During the last scheduled class, a colleague administered the SD and ATS surveys.

Results

Attitude and achievement data were compared via a series of t tests and analysis of variance. Although the study design lacked randomization, as already described, descriptive data failed to yield a significant difference between classes at the start of the

study. This, in concert with concern as to the identification of a suitable covariate (Campbell and Stanley, 1966), it was decided not to use analysis of covariance. Results are presented separately for achievement and attitude data.

Achievement

As can be seen in Table 1, t-test results failed to indicate a significant difference in multiple choice scores between TRAD and COMP classes. This is unlike the t-test results for the open ended questions which approached significance ($p \leq .10$). Overall, for open ended questions, the TRAD class outperformed the COMP class. Conversely, the COMP class was more likely to correctly compute the desired statistic than their TRAD class counterparts.

Table 3
Mean Achievement: TRAD vs. COMP

	TRAD		COMP			
Item Type	Mean	S.D.	Mean	S.D.	t	p
Mult Choice	11.8	2.7	11.7	2.8	+0.2	.86
Open Ended	21.3	4.3	18.9	5.5	+1.8	.08
Stat Value	4.3	1.3	5.0	1.2	-1.9	.07

Attitude

Presented in Table 4 are the mean ATS Total, Field and Course scores for TRAD and COMP classes as well as the corresponding t values. Review of these data indicate that no significant difference was found between classes on measures of attitudes toward statistics, the discipline and the course.

Table 4
Mean TRAD and COMP ATS Total, Field and Course Scores

	TRAD		COMP			
Measure	Mean	S.D.	Mean	S.D.	t	p
Total ATS	100.2	16.4	100.7	13.9	-0.1	.90
ATS Field	70.5	11.3	72.4	8.9	-0.7	.48
ATS Course	29.7	7.4	28.3	6.9	+0.7	.47

Table 5 presents mean pre and post GEN SD scores while Table 6 presents the results of a three way mixed analysis of variance on these data. As can be seen in Table 6, significant main effects were obtained for Time (pre/post) and GEN SD Attitude (statistics, math, computers and psychology) in addition to a significant interaction between Time and GEN SD Attitude. Tukey pair-wise comparisons of the significant interaction, indicate mean statistics scores increased over Time. In addition, at pretest, mean statistics ratings were significantly lower than either computer or psychology ratings; math ratings at pretest were lower than psychology. At post test, no significant difference was found between attitudes.

Table 5
Pre and Post Mean SD Attitudes for TRAD and COMP classes

	TRAD		COMP	
Attitude	Pre	Post	Pre	Post
Statistics	15.5	19.4	16.4	19.7
Math	18.5	20.1	17.2	20.1
Computers	19.9	20.9	20.9	23.3
Psychology	23.3	23.2	22.1	23.7

Table 6
Analysis of Variance: Class by Time by SD Attitudes

Source	df	Sum of Squares	Mean Square	F	p
Between					
Class	1	7.91	7.91	0.13	.72
Error/Bet	44	2673.33	60.76		
Within					
Time	1	404.88	404.88	18.67	.00
Class x Time	1	21.67	21.67	1.00	.32
Error	44	954.20	21.69		
Attitude	3	1499.88	499.96	22.41	.00
Class x Att.	3	65.01	21.67	0.97	.41
Error	132	2944.86	22.31		
Time x Att.	3	98.92	32.97	3.40	.02
Cl x Ti x Att,	3	20.07	6.69	0.69	.56
Error	132	1281.26	9.71		

Table 7 presents the mean value ratings for TRAD and COMP class pre and post instruction. Similar to the SD Attitude data reported above, a three way mixed analysis of variance was computed. As can be seen in Table 8, the only significant effect obtained was a main effect for Value. Tukey pair-wise comparisons indicate that statistics value ratings were significantly lower than all remaining values. The difference between math and computer mean value ratings were also significant.

Table 7
Pre and Post Mean SD Value Attitudes for TRAD and COMP classes

	TRAD		COMP	
SD Value	Pre	Post	Pre	Post
Statistics	5.3	5.4	5.4	5.5
Math	6.1	5.9	5.8	6.3
Computers	6.4	6.6	6.3	6.7
Psychology	6.2	6.4	6.4	6.4

Table 8
Analysis of Variance: Class by Time by Value

Source	df	Sum of Squares	Mean Square	F	p
Between					
Class	1	0.16	0.16	0.04	.85
Error/Bet	44	202.75	4.51		
Within					
Time	1	1.94	1.94	1.42	.24
Class x Time	1	0.62	0.62	0.46	.50
Error	45	61.31	1.36		
Value	3	64.18	21.39	13.74	.00
Class x Val.	3	0.28	0.09	0.06	.98
Error	135	210.17	1.56		
Time x Val.	3	1.11	0.37	0.57	.64
Cl x Ti x Val.	3	2.00	0.67	1.03	.38
Error	135	87.51	0.65		

Discussion

A clear pattern in achievement between TRAD and COMP classes is not evident; TRAD students tended to outperform COMP students on open ended items while COMP students tended to outperform TRAD students in computing the correct statistical value. Although attitude data failed to indicate a difference between classes, positive attitudes toward statistics increased over the course of the semester across classes. The lack of a clear trend in the data between TRAD and COMP classes, may, to some extent, be interpreted as support for the efficacy of the manual in supporting students' data analyses. That is, COMP students were able to effectively and independently use relatively sophisticated statistical software.

Several factors may have limited our ability to find a clear trend in achievement data. One explanation is that there is no difference in achievement outcome between computer and calculator supported statistics instruction. Although given prior research (Layne and Huck, 1981; Ware and Chastain, 1989), this explanation is plausible, it does not limit either the interest or support for computer supported statistics instruction. As reported by Butler

and Kring (1984), faculty interest in expanding the role of computers in instruction is strong. Computer assisted introductory statistics instruction adds to the parsimony between introductory statistics and advanced statistics and research courses as well as thesis work.

A second explanation for the limited achievement results concerns the difficulty incurred when trying to develop a common core of items. Roger's (1987) believed that differences between computer and traditional statistics classes were so large that it was not possible to compare students' performance across instructional modes. In the development of a common item set, instructors agreed that in order to be included, a question must pertain to material covered in both classes; in so doing, students in either class could be reasonably expected to correctly answer the item. This important constraint made it difficulty to select common core items. The use of the computer may, for example, permit students to acquire more in-depth understanding of particular concepts. Questions to document this, however, would not meet the criteria, and were not included. Although a common item set was developed for the current study, the instructors had difficulty in reaching agreement, and question the extent to which the core items represent the content and breadth of either class. This limitation is inherent in studies of this sort in which instructional modes are compared. Efforts to articulate the objectives and anticipated outcomes of introductory statistics classes may help to increase the content validity of tests used in future research.

Despite limited quantitative findings to support the superiority of computer based statistics instruction, COMP class students were able to effectively use powerful computer software. At various junctures in the semester, students expressed pride in their computer skills and appreciation for the computer resources available. This is particularly noteworthy in that it has been our experience that even the computer literate researcher at times has had difficulty using SPSS. Although many easier programs have

been developed for elementary statistical calculations (Rogers, 1987), student experiences within the current study indicate that ancillary materials can be developed to allow students to use the same software as professionals working in the discipline. Future studies should seek to refine qualitative measures to include information concerning such dimensions as students perceptions of their own computer literacy.

In summary, the data did not yield differences in attitude or achievement between COMP and TRAD classes. Although the superiority of computers in engendering positive attitudes or higher level skills is not supported, no evidence to suggest that computers detract from introductory statistics instruction was observed. In this manner, the old adage which suggests that hand or calculator supported statistical calculations is a valuable component in introductory statistics classes was not supported. Although future research should continue to develop more sensitive measurement of the variables of interest, the current study provides support for the ability of introductory students to use discipline based computer software. It is our belief that increasing students contact with these resources has the potential to help students in future research activities and job search activities.

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